Study of Scintillation, Fluorescence and Scattering in Mineral Oil for the MiniBooNE Neutrino Detector

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1 Overview

The primary signal for the MiniBooNE detector is Cherenkov light (prompt and directional). Ionization produces scintillation signals (time delayed and isotropic) which are observed as the only signal for particles produced with velocities below Cherenkov threshold and as additional light for other produced particles. The detector consists of a 12-m sphere filled with mineral oil and lined with phototubes to detect the produced light. In order to understand the spatial and time distribution of the detected signals, we are studying a variety of optical properties of the oil.

2 Scintillation

By placing a flask of oil in the RERP beamline at the Indiana University Cyclotron Facility, we are able to study scintillation with protons which are below threshold for Cherenkov light production in this oil. At low intensities, the light is observed with a single photomultiplier tube and a time response measured with respect to the incident protons. At higher intensities, spectral response is measured by sampling the light with a quartz fiber and sending the light into a spectrophotometer.

3 Fluorescence

Both at Fermilab and at Johns Hopkins, spectrofluorometers are available to study the fluorescence spectra from this oil. Studies have been carried out over a wavelength band from 200 to 600 nm. A variety of excitation and emission spectra are measured and details of various line spectra have been studied. At Johns Hopkins, time-resolved fluorescence measurements excited by a laser have been carried and to resolve the time distribution of light created by fluorescence. Both short (about 1 ns) and long (>20 ns) components have been seen.

4 Scattering

Studies at Princeton University explore the scattering for 530 nm light as a function of angle and polarization.

5 Internal Calibration

The MiniBooNE detector has a laser calibration system, an external cosmic ray muon hodoscope, internal scintillation cubes for calibration as well as a variety of calibrations from the data stream, including Michel electrons from muon decay. Information from these sources of data directly obtained from the detector will be combined with information from special test systems to provide the required information on the optical properties of the oil.

6 Summary

Using the data from these systems, an optical model of the MiniBooNE detector is constructed to guide construction of fitting algorithms and as input the Monte Carlo simulation of the detector. The results of these measurements will be reported and their effects on the MiniBooNE detector will be evaluated.